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The American Midland Naturalist

Devoted to Natural History, Primarily that of the Prairie States

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The American Midland Naturalist

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ECOLOGIC INTERPRETATIONS OF SOME BIOSTRATIGRAPHIC TERMS

CARROLL LANE FENTON AND MILDRED ADAMS FENTON

II. ZONE, SUBZONE, FACIES, PHASE.

ZONE AND SUBZONE

In a previous paper[1] we have proposed and discussed a term, zonule, which we regard as applicable to the smallest division of a zone which the biostratigrapher will be called upon to make. It remains for us to make clear the relationship of such divisions to the larger ones called zones and subzones.

The term zone originally was proposed by Oppel for "divisions less than stages based on paleontological characters alone, and extending, if not over the whole world, far beyond the limits within which lithological distinctions remain constant."[2] In Europe, zones largely have been determined by the vertical range of a few selected fossils, such as species or even subspecies of echinoids or ammonites; but in America much more latitude has been allowed in their delineation. As a guide one naturally turns to the

[1] This Journal, vol. 11, pp. 1-23, 1928.

[2] Davis, An Introduction to Paleontology, p. 381, 1925.

United States Geological Survey whose procedure, as stated in a letter by Dr. Julian Sears, is as follows:

"It is the established practice of the Geological Survey to use the word *zone* as a convenient and somewhat indefinite stratigraphic term covering the vertical interval through which a species or larger biologic group ranges or is especially abundant or characteristic, without particular reference to the lithologic units that may be recognized and mapped. Obviously zones thus established will differ greatly in size since the known range of a species or genus may be in one case only a few inches and in another thousands of feet. Sometimes when several paleontologic divisions of a zone are recognized the smaller units are called subzones."

A subzone, therefore, is a division of a zone which, by virtue of the fact that it is determined vertically and not areally, should be essentially co-extensive with the zone of which it is a part. It may include, however, any number of zonules; stratigraphic divisions which are closely limited in area as well as in thickness. The relationships of these three terms, therefore, may be indicated in the following diagram:

<table>
<tr><th colspan="2"></th><th>Area 1</th><th>Area 2</th><th>Area 3</th></tr>
<tr><td rowspan="4">Zone</td><td rowspan="2">Subzone</td><td rowspan="2">Zonule</td><td>Zonule</td><td>Zonule</td></tr>
<tr><td colspan="2">Zonule</td></tr>
<tr><td rowspan="2">Subzone</td><td colspan="2">Zonule</td><td>Zonule</td></tr>
<tr><td>Zonule</td><td>Zonule</td><td>Zonule</td></tr>
</table>

From the viewpoint of ecology, a zone, unless determined on the basis of a very small number of organisms, probably will represent the duration of an aggregate large enough to be called a fauna or a flora. In such a case, the subzone will represent a stage in the development or modification of this major biotic group—providing the modification is not so great as to represent a new stage in a succession over the entire area involved, in which case the determination of a new zone probably will be required. Correlation, however, can be only approximate, for the very nature of the fossil record, as well as differing opinions among paleontologists, inevitably will prevent uniformity in application of either zone or subzone; and both must be applied to stratigraphic divisions whose faunal representatives are far too scanty for ecologic interpretation.

FACIES

The paleontologist often desires to unite under one term both the faunal and sedimentary characters of a zone or a formation, without inquiry into details of stratigraphy and ecology, or without separation of rocks and fossils, even though the details are known. This need was felt long ago by the Swiss geologist Gressly, and met by him with the term facies.

"Je suis parvenu," says Gressly, "a reconnaitre, dans la dimension horizontale de chaque terrain, des modifications diversees, bien determinees, qui offrent des particularites constantes dans leur constitution petrographique asussi bien que dans les characteres paleontologiques de l'ensemble de leurs fossiles, et qui sont assujetties a des lois propres et peu variables."[3] To these "modifications" he gave the name *facies*, or "aspects de terrain."

[3] "I am prepared to recognize, in the horizontal extent of a terrane, various modifications, clearly distinguised, which offer constant peculiarities in their petrographic constitution as well as in the paleontologic characters of their fossil assemblages, and which are subject to definite and but slightly variable laws." Nouv. Mem. de la Soc. Helv. des Sci. Nat., vol. 2, p. 11, 1838.

Although relatively uncommon in American stratigraphic literature, facies is regularly employed in the writings of European geologists. One of the more recent definitions of the term is that of Haug: "Par facies geologique, nous entendrons donc *la somme* des characters lithologiques et paleontologiques que presente un depot en un point determine." "The sum of the lithologic and paleontologic characters which a deposit presents at a given point." The definition is clear and brief, but it offers room for confusion unless one restricts the word deposit to the formation as originally formed, excluding secondary changes that are wholly independent of its original nature.

Examination of the general discussion by Haug, and the usage by the men whom he quotes, supports this restriction. On the petrographic side, *facies* involves only those characters which are concerned with the original formation of the sediments to which it is applied. Later developments, such as secondary brecciation, faulting, and metamorphosis, do not enter into the facies concept. To include them would be to destroy its unity and its practical, as well as its ecological sifinificance. The last may have been but dimly perceived by Gressly and other pioneer geologists who used the term, but it is too valuable to be lost.

Facies, therefore, is a term which denotes both the fossil content of a given stratigraphic unit and the characteristic of the rocks which compose it. In significance, the term is general rather than specific; and in many cases, ecologic rather than geologic. For the fossils represent one-time organisms, and in the majority of cases the strata record, however inadequately they may reveal, the environment in which those organisms lived. There are exceptions, of course, as when pelagic or planktonic organisms are buried in bottom muds, or land-dwellers in water-laid sediments—but they are not so abundant as to rob the generalization of its value.

It must be remembered, also, that restrictions upon the ecologic significance of the term facies are less strict than

those affecting the terms faunule and zonule.[4] For the latter supposes the existence or record of an organic community, while the former demands only the remains or traces of animals or plants, in sediments which once formed, or which give evidence of their inorganic environment. There may be but one or two species, represented by few and scattered specimens; yet the light thrown upon their one-time surroundings may be as great as that which similarly illuminates a faunule. And even though it is absent, the term facies still may be used as a convenient designation.

It is doubtful, however, that in paleontology or stratigraphy its application should be extended further. In igneous geology the use of facies may cause no trouble; one is not apt to confuse a diorite with a limestone. But to bring the term into paleontology and speak, as some have spoken, of the several facies of a fauna is to invite misunderstanding. The fields overlap too often, and join too closely; unless an author constantly qualifies, his readers will be in doubt as to his meaning. Such qualification inevitably must be clumsy, and since the biostratigraphic usage clearly has priority, it well may be given the field.

PHASE

In addition to those areal variations in faunas and sediments which are included under the term facies, there are others, of importance to the stratigrapher which cannot properly be brought into the province of that term. They arise, not from conditions obtaining at the time of deposition, but from changes arising at later—often much later—date. Typical of these are faulting, folding, secondary dolomitization, and erosion; and in so far as they depend upon such factors, areal variations are independent of the original nature of the strata, and so cannot determine facies.

As has been suggested, such variations nevertheless may be of importance to stratigraphers, since they determine

[4] This Journal, vol. 11, pp. 17, 21, 1928.

both the aspect of rocks, and their fossil content. They must be described and referred to; and for this purpose some designation is necessary which will distinguish them from facies. A convenient one, already in use,[5] is the term phase. It may be defined as follows:

A phase, in stratigraphy, is a local or regional aspect or condition of a stratum or group of strata, as determined both by original nature and secondary change; the latter being the determining factor.

In practice, of course, it frequently may be necessary to distinguish phases, some of which are virtually free from secondary change. Yet this need not violate the definition, for phases will not be distinguished unless at least two are presented in any given stratigraphic unit; and they will be distinguished by the presence, in all but the unmodified phase, of the results of secondary change. Thus a continuous bed of limestone which in one district is unmodified and in another folded or brecciated will have two phases—even though the facies may be identical.

In listing factors which modify strata and thus distinguish phases we would include those forms of contemporary weathering, erosion and deposition which result, for example, in the "fucoidal" beds of the Plattin[6] in Ste. Genevieve County, Missouri, and in near-surface cherts. It is but logical, therefore, that ancient weathering and erosion also should be included—particularly when they result in pebble-layers formed from subjacent strata, and in unconformities. It is true that these approach closely the factors determining facies, but the danger of confusion is more apparent than real. Overlap, for example, is caused by advancing deposition in an encroaching sea—one cause of facies; but the erosion of the underlying beds, perhaps with antecedent deformation, may long have antedated the encroaching sea. On the other hand, unless erosion is a

[5] Belanski, C. H., This Journal, vol. 10, pp. 317-370, 1927.

[6] Fenton, C. L., This Journal, vol. 11, pp. 89, 92, pl. 4, fig. 10, 1928.

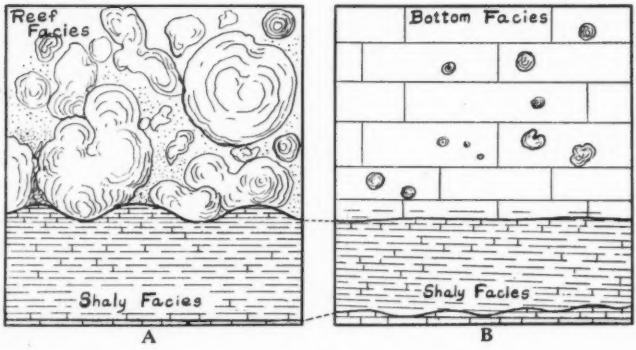

FIG. 1.

Diagrammatic representation of facies and phases in continuous strata. In A the upper member consists of a well-marked stromatoporoid reef; in B it is a regularly, horizontally bedded limestone with few, small stromatoporoids, and the distinction between the two facies is primarily ecologic. The underlying shale, on the other hand, presents one continuous facies. By virtue of unconformities, however, the complete sets of strata at localities A and B may be said to form distinct phases.

mere interruption in the general process of deposition, it belongs in the class of subsequent modifying factors, and its results call for the term phase.

Since the phenomena included by that term are secondary or subsequent, they commonly affect more than one member or stratum. Thus in the Shellrock Stage of Iowa, Belanski finds that dolomitization, fracturing and even erosion are locally so concentrated as to distinguish the phases which he follows in organizing his description of the strata. To these phases he gives names derived from localities, and the practice seems generally applicable, though instances may arise in which descriptive names will be more useful.

PRIORITY AND PERMANENCE OF NAMES

It seems desirable, if only for the sake of convenience, that the rules of priority which apply to biologic names should be applied where possible to stratigraphic ones as well. If two men describe the same formation under different, but equally suitable names, it seems reasonable that he who publishes first should be followed. In the case of homonyms, on the other hand, priority seems quite as significant—and the safest guide away from confusion.

In the names of such minor stratigraphic units as zones, facies, phases and the like, however, it may be undesirable to hold strictly to those rules of priority which apply in biologic nomenclature. The men who settle a new country are more sentimental than inventive when they set out to name towns, hills and streams, so that in some districts the supply of local names available to stratigraphers is almost exhausted. Authors are forced to christen tiny creeks and uncertain hills to provide designations for strata, and if rules of priority were applied in the case of facies and phases, even this resource soon would be exhausted. But such a course seems unnecessary; phases (and even zonules) are such localized affairs that homonyms will cause but little trouble if only they are widely separated in place and age. It would do no harm if the name of an Ordovician phase in Ohio were identical with that of a Triassic one in Nevada—though if the two were in adjoining states the conflict might be serious.

In the case of stratigraphic names derived from organisms another qualification becomes necessary. Fossils may endure for ages, but their names are shorter lived. Sooner or later the shell that was *Orthis* becomes *Schizophoria*; faulty identifications, when corrected, give new specific names. Thus it develops that a zone named for one fossil bears the name of another—or an old name for the same one, which is quite as bad.

Such cases present a real problem. Nothing is more confusing, for example, than to find that a member of the Cedar Valley Stage of Iowa is known as the Spirifer pennatus beds or zone,[7] though the species for which it apparently is named is an index fossil of the Hamilton strata of New York and Ontario, apparently unknown in Iowa. If one searches persistently, of course, he will find that the Iowa species is *Spirifer pennatus* Owen, not Atwater—a synonym of *S. iowensis* Owen.[8] But the user of geologic literature does not always have time for such search; nor is it quite reasonable to ask him to spend it so, even if he does.

It seems, therefore, that stratigraphers and paleontologists, when using the names of fossils for stratigraphic units, should bind themselves to follow such changes as those names, by virtue of new research and the accepted rules of nomenclature, are forced to undergo. The only reasonable alternative is to incorporate the names of the author, as well as that of the species, into the stratigraphic designation. Such a plan would prevent much confusion, of course, but it still would be a makeshift, forcing constant reference to bibliographies, and entailing formation names of unwieldly size. It would bring, moreover, no relief in the case of those stratigraphic names which are based on wrong identifications, or on broadly conceived species later divided into more precise ones, or into varieties. For these the only possible remedy is to revise old names to fit new biologic concepts.[9]

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[7] Calvin, Iowa Geol. Surv., vol. 8, pp. 227, 229, 1898; *ibid.*, vol. 13, pp. 39 ff., 1902; Beyer and Williams; *ibid.*, vol. 17, p. 315, 1907; Beyer, *ibid.*, vol. 24, p. 98, 1913, etc. References are not merely to the strata, but to *Spirifer pennatus* as a species, without indication of the author.

[8] See Schuchert, Bull. 87, U. S. Geol. Surv., p. 393, 1897.

[9] We have not always thought so: see The Stratigraphy and Fauna of the Hackberry Stage, p. 9, note 1. We now regard the course suggested in that note, and followed in the book, as confusing and inadvisable.

CONTRIBUTIONS TO THE COAL MEASURE FLORA OF ILLINOIS

J. H. HOSKINS

Carboniferous petrifactions known as "coal balls" have long been known from Europe, and much of our knowledge of Carboniferous plants has been derived from a study of these petrifactions. Coal balls have been collected in America, however, but for a comparatively short time. The purpose of this paper is to contribute to our knowledge of this coal ball flora by adding certain new members to the growing list of American Carboniferous plants with structure preserved, with brief anatomical descriptions of the species listed.

The plants included in this paper are described from sections of coal balls collected from various localities in Illinois, either by the writer, or by Dr. A. C. Noé, under the authority of the Illinois Geological Survey. All were found in the McLeansboro formation, the approximate time equivalent of the Conemaugh of Pennsylvania.

BOTRYOPTERIDACEAE

1. *Botryopteris forensis* Renault (5, 6, 7).

The petiole only of this plant is known from Illinois, but is a rather common fossil (fig. 1). The details of this specimen were first worked out by Mr. Harry Muegel, and whose account may well be given.

The petiole measures 6-8 mm. in diameter; the stele (fig. 3) approximately 1.8-2 mm. The eliptical band of xylem of the petiole is in the form of a small omega, with the three arms elongated and so arranged that they almost meet at their extremities. Protoxylem is present at the extremity of each arm.

The large tracheids of the xylem are closely pitted, with the pits elongated at right angles to the major axis of the tracheid in a manner often described as reticulate. The

pitted tracheids grade into scalariform as the smaller xylem cells nearer the extremities of the three xylem arms are reached, while the small protoxylem cells are either spiral or annualar.

Most of the tissue lying between the arms of the xylem and immediately exterior to the stele is absent. However, there are almost always two small areas of sclerotic tissue between the xylem arms (fig. 3). The cortex is extremely uniform in structure, showing little differentiation other than the gradual reduction in diameter of the peripheral rows of cells, together with a corresponding proportional increase in the thickness of the cell wall.

Multicellular hairs are common to the genus, and while they are frequently observed attached to the petiole of this specimen (fig. 2), the "equisetoid" character of the hair peculiar to *B. forensis* has not been determined with certainty. The great similarity of the structures of the petiole, comparable size and approximate geological horizon of this specimen and *B. forensis* Renault, all point to the identical nature of the two; the failure to identify positively the peculiar undulation of the transverse walls of the multicellular hairs, which gives them the "equisetoid" appearance, is not here considered sufficient to forbid the identification of the Illinois specimen as *B. forensis.*

2. *Botryopteris hirsuta* (Will) (2, 3, 8, 9).

The petiole of this plant, which is the only part known from Illinois, is a very common fossil in our coal balls (fig. 4). In a preliminary report (3) the provisional specific name *Illinoensis* was employed. Later investigations show its similarity with *B. hirsuta* (Will).

The petiole may measure as high as 4 mm. in diameter. The three arms of the xylem of the petiole are much less prolonged than in *B. forensis* Renault, and the cortex is differentiated rather definitely into two zones, an inner region composed of cells with a comparatively large diameter, grading rather sharply into an outer zone of smaller sclerotic cells.

The pitting of the tracheids is similar to that described for *B. forensis*, while the petiole as a whole is remarkably similar to the petiole described by Felix (2) as *Rachiopteris tridentata*, which is now known to be the petiole of *B. hirsuta* (Will). Also similarly to *B. hirsuta*, the number of protoxylem points of the bundle of the petiole is occasionally reduced to two.

An interesting detail is shown in the figured specimen (fig. 4), and is true of many sections under observation. The central arm of the xylem is slightly bifurcated at its extremity and has two protoxylem points. In all sections observed with three protoxylem points, the central xylem arm terminated quite obtusely, with a relatively broad protoxylem region. This agrees thoroughly with the figured specimen of Felix, and while it may become necessary to revise the nomenclature of this plant should the discovery of other parts of the plant than the petiole make it necessary, it appears at present that the agreement in detail between this specimen and *B. hirsuta* (Will) is sufficient to warrant the inclusion of the Illinois plant within that species.

3. *Anachoropteris involuta* sp. nov.

The type genus of the Anachoropterideae is *Anachoropteris* Corda (1), of which the petiole and fructification are known, the stem not having been observed. The characteristic feature of this genus is the extremely revolute margins of the xylem strand of the petiole. It also appears that the convex side of the bundle is turned toward the stem, judging from the shape of the petiole in transverse section, which is an unusual feature.

In the petiole of *A. involuta*, which has a diameter of 6.5-7 mm., (fig. 5), the margins of the concentric vascular bundle are much more revolute than in *A. pulchra* Corda. The xylem strand is 3 mm. in diameter. Similarly to *A. pulchra*, strands of sclerenchyma, attached to the cortical tissue on the concave side of the bundle, follow the intricate pattern of the xylem. Also similarly to *A. pulchra*, the convex side of the bundle seems to have been turned toward the stem.

The larger tracheids are closely pitted; the smaller ones near the protoxylem are scalariform. Studies of the protoxylem have been made with difficulty owing to the state of preservation, and while two protoxylem groups can be identified, one giving rise to a pinna trace, it has not been possible to identify four protoxylem groups as was sometimes true of *A. pulchra*.

The cortex has no unusual features. It is relatively thick, with an inner and outer region, the latter being composed of very small sclerotic cells.

While it is difficult to assert positively that this specimen is not a variation of *A. pulchra* Corda, we are led to the conclusion that this is a new species because of the extreme variation of the xylem strand of the petiole, and its relation to the comparative diameters of this specimen and *A. pulchra*. The possible range in size of the petiole of *A. pulchra* is not known, but based on figures available, this specimen unites a more elaborate arrangement of the xylem with a smaller petiole and bundle measurement, which is the reverse of the expected condition if the two are identical species.

LEPIDODENDRACEAE

1. *Lepidodendron* sp.

A small stem, 2 mm. in diameter, obviously belonging to the Lepidodendraceae, was found in one petrifaction. Unfortunately, all tissues exterior to the xylem are absent, and from this specimen alone, it is impossible to determine whether the plant was too small for the formation of secondary wood, or whether it belongs to that group of Lepidodendraceae which are not known to form secondary wood.

Two interesting conditions may be noted in fig. 6. In the first place, while there is a rather definite demarcation between the primary wood and the medullary region, the latter is composed of quite thick walled cells, possibly lignified. There is not an admixture of thin walled parenchyma with cells with lignified walls such as is the situation in *Lepidoden-*

dron (Lepidophloios) selaginelloides Sternberg, where the central region of the stele is composed of parenchymatous cells and shortened tracheids with scalariform thickenings. While the central region of this specimen shows a considerable variation in cell size, none are thin walled, neither is there any evidence in the sections available of any scalariform markings which would indicate the presence of tracheids in this region. The occurrence of such tracheids would be an argument in favor of considering this plant as *L. selaginelloides*.

A second interesting feature is the extreme crenulations of the outer edge of the primary wood, which terminate with the protoxylem cells, quite comparable with the Lower Carboniferous *L. Harcourtii* Witham. It is also similar to *L. Harcourtii* in the method of cutting off the numerous leaf traces from the side and not the extremity of the xylem protuberances. The leaf traces, proportionately large in comparison with the diameter of the axis, have the protoxylem cells rather centrally placed, a not unusual feature of foliar traces of lycopods.

In the absence of more complete specimens, it seems desirable to await further researches before attempting to give this interesting plant a specific identity.

PSARONIEAE

1. *Psaronius* rootlet.

The frequent occurrence in the Illinois petrifactions of isolated rootlets of *Psaronius* has been noted (4), together with a general discussion of their structure. The perfect preservation of the stele of some of these rootlets more recently observed is remarkable. Fig. 7 presents a photomicrograph of such a stele with a diameter of 1.2 mm. There are seven radial arms of the xylem, each terminating with a number of very small protoxylem cells with spiral thickenings. Some parenchyma is seen in the center of the stele. Lying between the arms of the xylem, in the typical root fashion,

are the phloem regions. The pericycle of one row of cells opposite the protoxylem cells, and of two rows elsewhere is followed in turn by the endodermis.

In some of the petrifactions these roots are quite the most common fossil. They do not seem to be a part of the "root-zone" of some *Psaronius* stem, but rather the outer, so called "free" rootlets of the plant.

University of Cincinnati.

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EXPLANATION OF FIGURES

Fig. 1. Petiole of *Botryopteris forensis* Renault. × 10.
Fig. 2. Multicellular hairs attached to petiole.
Fig. 3. Detail of the omega-shaped xylem strand of the petiole. × 32.
Fig. 4. Petiole of *Botryopteris hirsuta* (Will). × 32.
Fig. 5. Petiole of *Anachoropteris involuta*, showing the extremely revolute margins of the xylem strand. × 30.
Fig. 6. Lepidodendron stem, showing the leaf traces, prominent protoxylem angles, the primary xylem and medullary region. × 35.
Fig. 7. Psaronius rootlet. The stele with all tissues well preserved is shown. × 35.

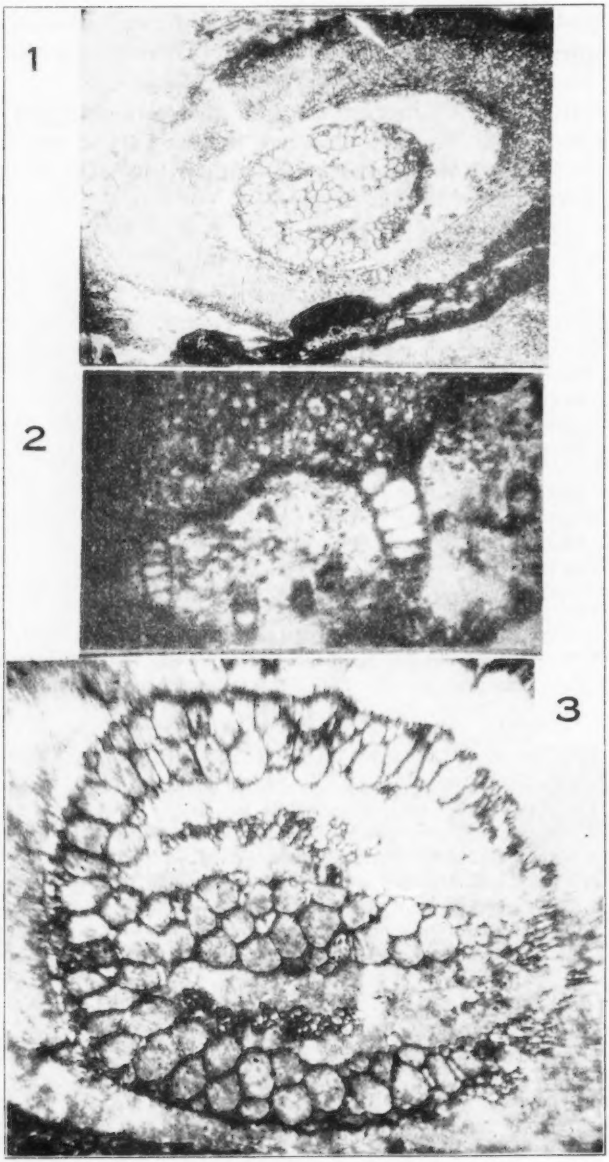

Plate I.

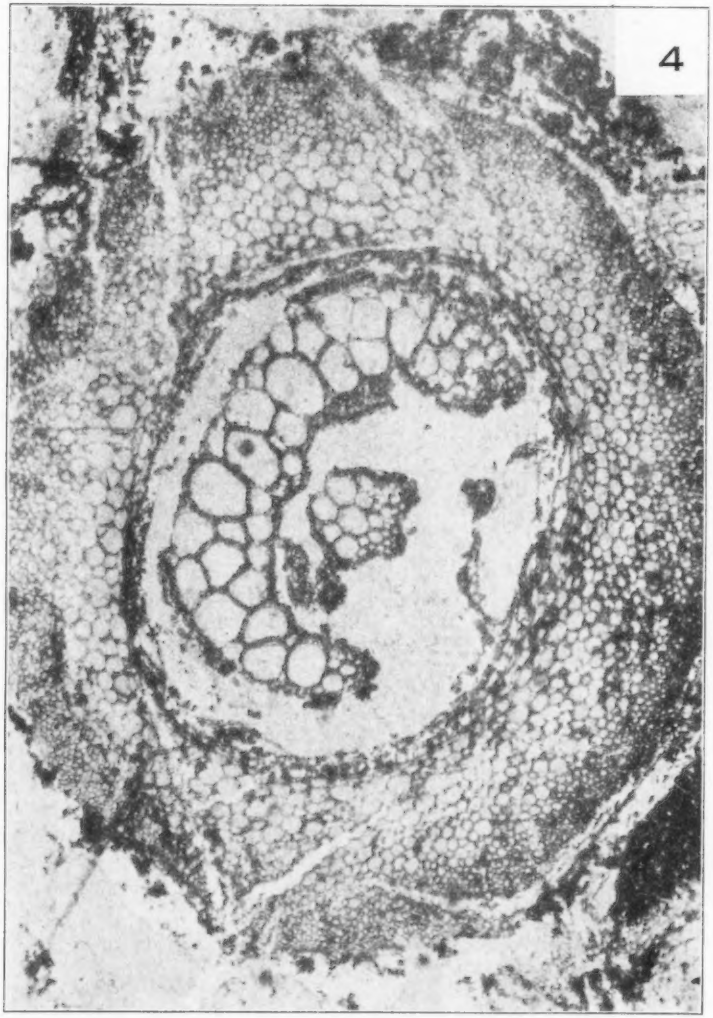

Plate II.

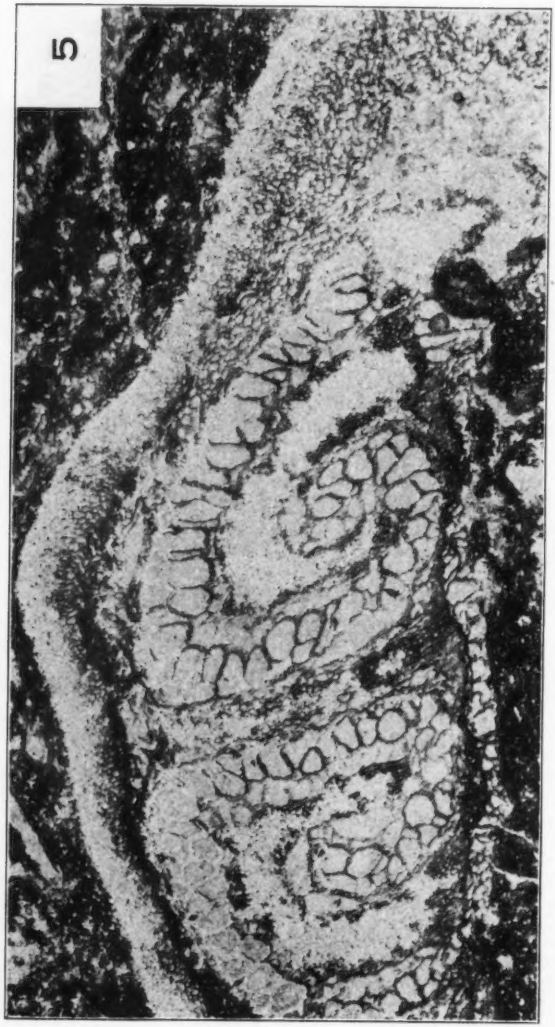

Plate III.

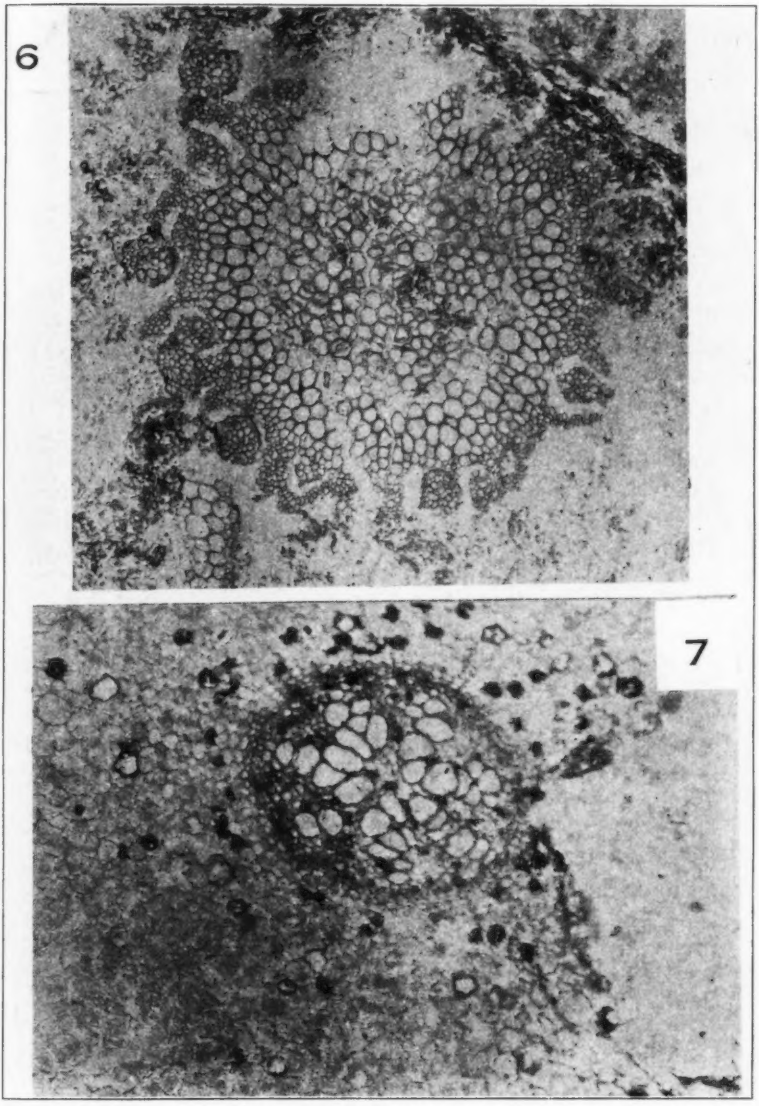

Plate IV.

BOOK REVIEWS

THE SCIENCE OF BIOLOGY. George G. Scott. 633 pages. Thomas Crowell. $3.75.

This book is written upon what might be termed the survey-cultural descriptive plan and as tested, out is advantageously unique in arrangement from the standpoint of the teacher. The author first reviews plants and animal life through the study of type forms and in the theoretical order of evolution, introducing biological principles and theories with each phylum. Botanical subject matter is more abundant than in most texts of this kind, hence the leading features of plant as well as general biology are amply covered. Thus over half of the content of the volume is devoted toward developing an adequate foundation for the survey material of the rest of it. The sections on the various divisions of biological science such as classification, embryology, genetics, etc. are preceded by a comprehensive chapter on the cell and protoplasm, which is, consistently enough, one of the longest in the book. Where the most important biological problems are discussed, it is with illustrations drawn largely from the vertebrates as being the closest of all creatures to man. This humanizing attitude to be traced in the entire work culminates in a final chapter on the biology of man. Despite the temptation to be encyclopaedic which is encountered in writing a text of this type, the author has produced a well balanced and well illustrated volume which should be especially advantageous for use with students who plan to take but one year of biology in college.—Reviewed by N. M. Grier, Evansville College, Evansville, Indiana.

THE OUTLINES OF MODERN BIOLOGY. Charles Robert Plunkett. 691 pages. Henry Holt. $3.75.

This generation sees biologists who are no longer natural historians or morphologists representative of the older school but instead are chemists and physicists of living matter, albeit still teaching their subject largely from texts mostly based on the older discipline. It has not been uncommon for teachers of biology to regard their field as somehow being more difficult for students than that of other sciences, and possibly this impression is reflected by the less stimulating character of many collegiate texts published in the past. In the present work, however, the author's aggressive attitude toward modernizing collegiate biology is expressed by his statement that his book is no more difficult than modern college textbooks of physics and chemistry, and that he perceives no good reason why they should be less so, in view of the greater inherent complexity of the subject matter of biology. Progressive teachers of biology will unquestionably be in sympathy with this attitude.

Dr. Plunkett builds his book around the concept of the living organism as a physico-chemical mechanism, the emphasis being on general principles rather than on the factual details one associates with a text written from the basis of the type system. The initial theme of protoplasm is amplified into sections dealing with the comparative physiology of plants and animals under the headings of nutrition, response, reproduction, and evolution. The many still unanswered questions of biology are not ignored but viewed as stimulating problems rather than discouraging mysteries. A thoughtful chapter on the origin and nature of life concludes the volume, while his last statement crystallizes the central problem of biology today—that the essential "secret of life" lies in the genes themselves; their composition and structure, how they are autocatalytically synthesized, and how they may have first originated from lifeless matter.

Not only has the author given us a useful and tested text but it is highly probable that it is pioneer to others of similar but more detailed plan. It is to be especially recommended for the use of students who have had some previous training in science.—Reviewed by N. M. Grier, Evansville College, Evansville, Indiana.

GENETICS. H. E. Walter. Third Edition. MacMillan. $2.50.

One of the most noted sayings of a revered university president was that any subject is liberal when taught in a liberal fashion. Such would characterize the method of presentation in this elementary textbook of genetics, reflecting as it does the winsome personality and superb skill of one of America's master teachers in the biological sciences.

The task of the author has certainly been no easier in this third edition for which a demand has been made. Genetics may be thought of as a science in its preadolescence and growing so rapidly that textbook clothing does not fit it very long. Upon reading this volume, however, one gains the impression that Dr. Walter has met with discrimination and foresight the problems involved in bringing the subject matter up to date in such a way as to include those advances in practice and theory which seem to indicate the path of its future. The book is to be highly recommended for the "interested but confessed layman" and is of the very type needed to kindle the enthusiasm of the beginning student of heredity. It should function also as an inspiring reference text for introductory courses in general biology.—Reviewed by N. M. Grier, Evansville College, Evansville, Indiana.

A SYNOPSIS OF THE GENERAL MORPHOLOGY OF ANIMALS. Edwin Grant Conklin. Princeton University Press. $1.50.

Some courses in introductory collegiate biology represent but a slight advance in organization over the materials of good secondary instruction in this science. On the other hand, those teachers who feel that one of the objects of the college curriculum is to challenge the intellect of the student as a way of training him how to think, will as knowledge in a particular field is increased and verified, include more of it in undergraduate courses. Thus, the content of this publication is that which twenty years ago would have been thought suitable only for a beginning graduate student, but we learn that it was designed for use in connection with the lectures, laboratory work and assigned readings in the morphological part of a course in general biology.

The synopsis deals with the subject from the genetical (embryological and evolutionary) point of view, "because it is easier to understand complicated structures when they are seen in the process of becoming." It consists of sections on taxonomy, the principles of morphology, and an analysis of the embryology and morphology of the Metazoa. The latter is presented from the standpoint of the physiology and structure of the organ systems, and is highly creditable for what it covers in so short a space. This book will be useful also to every teacher of the morphological aspects of zoology, as well as graduate students in that subject, especially because of its excellent illustrations and the comprehensive chart on the morphology of animals.—Reviewed by N. M. Grier, Evansville College, Evansville, Indiana.